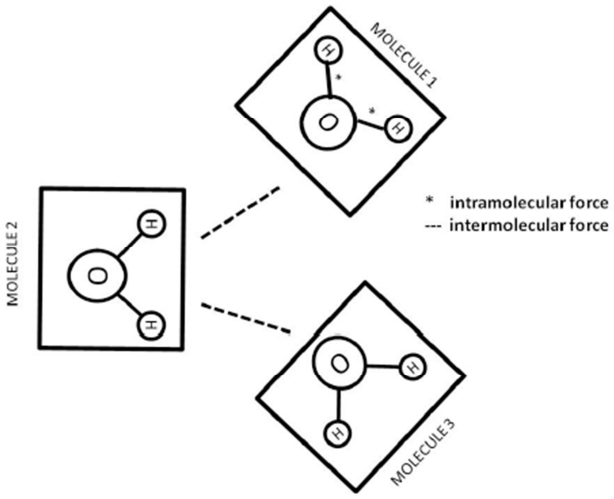
Name _____ AP Chemistry

Intermolecular Forces

As you have learned, matter is made up of discrete particles called atoms, which chemically combine together to form molecules. Molecules do not exist as independent units; in fact, groups of molecules 'stick together' in order to form solids and liquids. The forces that hold groups of molecules together are intermolecular forces.

Model #1: Intermolecular and Intramolecular Forces

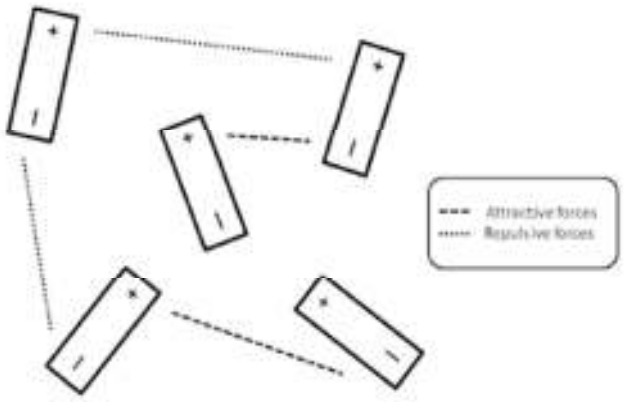


1) The asterisks show the intramolecular forces. Where are these forces located in relation to the molecules?

2) Two intermolecular forces are shown in Model 1. Where are they positioned relative to the molecules?

3) State, in everyday language, the difference between intermolecular and intramolecular forces in terms of where they occur on the molecular level.

Model #2: Dipole-dipole interactions

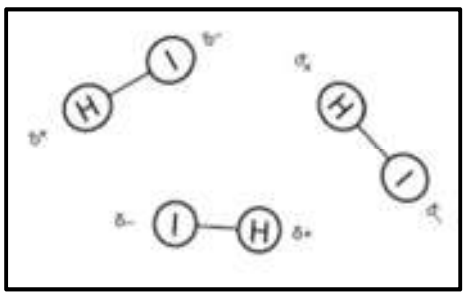


4) Molecules, represented above as bars, demonstrate known as dipoles. Define what a dipole is, based on this image.

5) There are attractive and repulsive forces shown in Model #2. In relation to the molecules, which parts are the attractive forces found between? What about the repulsive forces?

A dipole is most often found in polar covalent molecules, in which the electrons are unevenly shared. This uneven sharing gives one side of the molecule a partially positive charge (ς^+) and the other side a partially negative charge (ς^-).

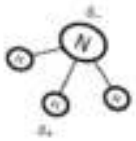
6) In the diagram below, a hydrogen iodide molecule has been drawn with its partial positive and partial negative charges. Using the three molecules in a box, draw an attractive force between two HI molecules using a dashed line (- - -) and a repulsive force between two HI molecules using a dotted line (…).



7) The forces described in #6 are called dipole-dipole interactions. Nonpolar molecules do not have dipole-dipole interactions while polar molecules do. Explain why this statement is true.

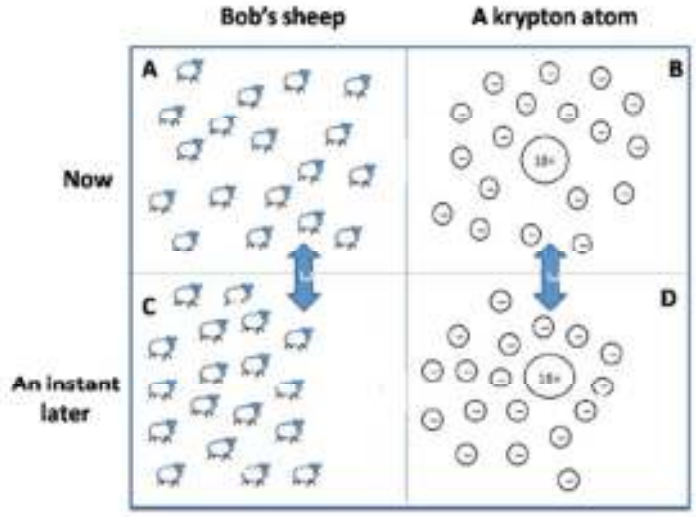
When a hydrogen atom is covalently bonded to nitrogen, oxygen or fluorine, a very strong dipole is formed. The dipole-dipole interactions that result from these dipoles are known as hydrogen bonding. Hydrogen bonding is an especially strong form of dipole-dipole interaction.

8) Below is a molecule of ammonia. Draw two more ammonia molecules in the box, indicating the partial positive and partial negative ends of each molecule.



9) Draw attractive forces (- - -) between the ammonia molecules. Label these lines as hydrogen bonding.
10) Label one covalent bond on an ammonia molecule.
11) Name one similarity and one difference between hydrogen bonds and covalent bonds.

Model #3: London Dispersion Forces



12) Bob's sheep like to wander around the pasture. They can be found anywhere at any moment. Describe the location of the sheep in box A and box C.

13) Now look at the krypton atom in box B and D. Is each atom neutral? Explain.

14) Describe the distribution of the electrons in box B and D.

15) The arrangement in Box D can be described as having a 'momentary' dipole. Explain why.

Even though atoms by themselves are electrically neutral, a momentary imbalance of electrons can create a momentary dipole. These dipole-dipole interactions among the momentary dipoles are known as London dispersion forces. These forces, also known as van der Waals forces, help neutral atoms and molecules attract each other.

16) The difference of electronegativity between hydrogen and bromine is 0.7, and the difference in electronegativity between hydrogen and chlorine is 0.9. Which would exhibit stronger dipole-dipole interactions, HBr or HCl? Justify your answer.

17) Neon has ten electrons, and krypton has eighteen electrons. Which element do you think has a greater chance of forming a momentary dipole? Which element do you think exhibits greater London dispersion forces?